Claims

[c1] 1.A method for generating a simulated patient image, the method comprising:
obtaining image data from an actual patient image;
generating simulated noise data; and
combining said image data with said simulated noise data to create the simulated patient image.

[c2] 2.The method of claim 1, further comprising:
combining scan data from said actual patient image with said generated simulated noise data to create pre-image data; and
reconstructing said pre-image data to create simulated image data.

[c3] 3.The method of claim 2, wherein said simulated noise data is generated through a random number generator in accordance with a Poisson distribution.

[c4] 4.The method of claim 3, wherein individual scan data samples from said scan data are each combined with a random noise value generated from said Poisson distribution random number generator, said random noise value first being multiplied by a weighting factor to produce a weighted random noise value.

[c5] 5.The method of claim 4, wherein said weighting factor is determined in accordance with the equation:

$$a = \beta\sqrt{D\left(\frac{1}{\alpha}-1\right)}$$

wherein a is said weighting factor, β is a scale factor whose value depends on a data acquisition system (DAS) gain and the image processing characteristics, α is a tube current reduction factor relative to a tube current at which said actual patient image was taken, and D is a DAS signal level for a corresponding individual scan data sample.

[c6] 6.The method of claim 5, wherein, in addition to said weighting factor, each of said random noise values are further multiplied by an electronic noise scale factor prior to being combined with individual scan data samples, said electronic noise scale factor being determined in accordance with the equation:

$$\sigma_a = aN_nP$$

wherein N_n is said electronic noise scale factor due to non-quantum noise, a is

said weighting factor, P is said random noise value generated from said Poisson distribution random number generator, and σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image.

[c7] 7.The method of claim 1, further comprising:

creating a set of individual noise pattern images for each a plurality of phantom objects;

selecting at least one of said individual noise pattern images to be combined with said actual patient image; and

combining said at least one selected individual noise pattern image with said actual patient image, thereby creating the simulated patient image.

[c8] 8.The method of claim 7, wherein said selecting at least one of said individual noise pattern images is based upon a patient shape and an imaging technique.

[c9] 9.The method of claim 7, wherein said at least one of said individual noise pattern images is randomly selected.

[c10] 10.The method of claim 9, wherein if more than one of said individual noise pattern images is selected, then said noise pattern images are added together to produce a resultant noise pattern.

[c11] 11.The method of claim 10, wherein said combined noise pattern is scaled by a scaling factor, s, in accordance with the equation:

$$s = \frac{\sigma_a}{\sigma_p} \quad \text{; with}$$

$$\sigma_a = \sqrt{\sigma_f^2 - \sigma_0^2} = \sigma_0\sqrt{\left(\frac{1}{\alpha} - 1\right)}$$

wherein, σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image, σ_p is a standard deviation of randomly selected interpolated and summed noise pattern images, σ_f is a desired standard deviation desired for the simulated patient image, σ_o is a standard deviation of said actual patient image and α is a tube current reduction factor relative to a tube current at which said actual patient image was taken.

[c12] 12.The method of claim 11, wherein said noise pattern images are scaled by the

inverse square root of the number of said noise pattern images selected.

[c13] 13.A method for generating a simulated computer tomography (CT) patient image, the method comprising:

obtaining image data from an actual CT patient image taken at a first radiation dose;

generating simulated noise data; and

combining said image data with said simulated noise data to create the simulated patient image;

wherein the simulated image simulates said actual CT patient image taken at a second, reduced radiation dose with respect to said first radiation dose.

[c14] 14.The method of claim 13, further comprising:

combining scan data from said actual patient image with said generated simulated noise data to create pre-image data; and

reconstructing said pre-image data to create simulated image data.

[c15] 15.The method of claim 14 wherein said simulated noise data is generated through a random number generator in accordance with a Poisson distribution.

[c16] 16.The method of claim 15, wherein individual scan data samples from said scan data are each combined with a random noise value generated from said Poisson distribution random number generator, said random noise value first being multiplied by a weighting factor to produce a weighted random noise value.

[c17] 17.The method of claim 16, wherein said weighting factor is determined in accordance with the equation:

$$a = \beta\sqrt{D\left(\frac{1}{\alpha}-1\right)}$$

wherein a is said weighting factor, β is a scale factor whose value depends on a data acquisition system (DAS) gain and the image processing characteristics, α is a tube current reduction factor relative to a tube current corresponding to said first radiation dose, and D is a DAS signal level for a corresponding individual scan data sample.

[c18] 18.The method of claim 17, wherein, in addition to said weighting factor, each of said random noise values are further multiplied by an electronic noise scale factor prior to being combined with individual scan data samples, said electronic noise scale factor being determined in accordance with the equation:

$$\sigma_a = aN_nP$$

wherein N_n is said electronic noise scale factor due to non-quantum noise, a is said weighting factor, P is said random noise value generated from said Poisson distribution random number generator, and σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image.

[c19] 19.The method of claim 13, further comprising:

creating a set of individual noise pattern images for each a plurality of phantom objects;

selecting at least one of said individual noise pattern images to be combined with said actual patient image; and

combining said at least one selected individual noise pattern image with said actual patient image, thereby creating the simulated patient image.

[c20] 20.The method of claim 19, wherein said selecting at least one of said individual noise pattern images is based upon a patient shape and an imaging technique.

[c21] 21.The method of claim 20, wherein said at least one of said individual noise pattern images is randomly selected.

[c22] 22.The method of claim 21, wherein if more than one of said individual noise pattern images is selected, then said noise pattern images are added together to produce a resultant noise pattern.

[c23] 23.The method of claim 22, wherein said combined noise pattern is scaled by a scaling factor, s ,sin accordance with the equation:

$$s = \frac{\sigma_a}{\sigma_p} \quad \text{; with}$$

$$\sigma_a = \sqrt{\sigma_f^2 - \sigma_0^2} = \sigma_0\sqrt{\left(\frac{1}{\alpha} - 1\right)}$$

wherein, σ_a is a standard deviation of said generated simulated noise data to

be combined with said actual patient image, σ_p is a standard deviation of randomly selected interpolated and summed noise pattern images, σ_f is a desired standard deviation desired for the simulated patient image, σ_o is a standard deviation of said actual patient image and α is a tube current reduction factor relative to a tube current corresponding to said first radiation dose.

[c24] 24.The method of claim 23, wherein said noise pattern images are scaled by the inverse square root of the number of said noise pattern images selected.

[c25] 25. An imaging system, comprising:
a gantry having an x-ray source and a radiation detector array, wherein said gantry defines a patient cavity and wherein said x-ray source and said radiation detector array are rotatingly associated with said gantry so as to be separated by said patient cavity;
a patient support structure movingly associated with said gantry so as to allow communication with said patient cavity; and
a processing device for obtaining image data from an actual patient image;
means for generating simulated noise data; and
means for combining said image data with said simulated noise data to create a simulated patient image.

[c26] 26.The imaging system of claim 25, further comprising:
means for combining scan data from said actual patient image with said generated simulated noise data to create pre-image data; and
means for reconstructing said pre-image data to create simulated image data.

[c27] 27.The imaging system of claim 26, wherein said simulated noise data is generated through a random number generator in accordance with a Poisson distribution.

[c28] 28.The imaging system of claim 27, wherein individual scan data samples from said scan data are each combined with a random noise value generated from said Poisson distribution random number generator, said random noise value first being multiplied by a weighting factor to produce a weighted random noise

value.

[c29] 29.The imaging system of claim 28, wherein said weighting factor is determined in accordance with the equation:

$$a = \beta\sqrt{D\left(\frac{1}{\alpha}-1\right)}$$

wherein a is said weighting factor, β is a scale factor whose value depends on a data acquisition system (DAS) gain and the image processing characteristics, α is a tube current reduction factor relative to a tube current at which said actual patient image was taken, and D i s a DAS signal level for a corresponding individual scan data sample.

[c30] 30.The imaging system of claim 29, wherein, in addition to said weighting factor, each of said random noise values are further multiplied by an electronic noise scale factor prior to being combined with individual scan data samples, said electronic noise scale factor being determined in accordance with the equation:

$$\sigma_a = aN_nP$$

wherein N_n is said electronic noise scale factor due to non-quantum noise, as said weighting factor, P is said random noise value generated from said Poisson distribution random number generator, and σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image.

[c31] 31.The imaging system of claim 25, further comprising:
means for creating a set of individual noise pattern images for each a plurality of phantom objects;
means for selecting at least one of said individual noise pattern images to be combined with said actual patient image; and
means for combining said at least one selected individual noise pattern image with said actual patient image, thereby creating the simulated patient image.

[c32] 32.The imaging system of claim 31, wherein said means for selecting at least one of said individual noise pattern images is based upon a patient shape and an imaging technique.

[c33] 33.The imaging system of claim 31, wherein said at least one of said individual

noise pattern images is randomly selected.

[c34] 34.The imaging system of claim 33, wherein if more than one of said individual noise pattern images is selected, then said noise pattern images are added together to produce a resultant noise pattern.

[c35] 35.The imaging system of claim 34, wherein said combined noise pattern is scaled by a scaling factor, ,sin accordance with the equation:

$$s = \frac{\sigma_a}{\sigma_p} \quad ; \text{with}$$

$$\sigma_a = \sqrt{\sigma_f^2 - \sigma_0^2} = \sigma_0 \sqrt{\left(\frac{1}{\alpha} - 1\right)}$$

wherein, σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image, σ_p is a standard deviation of randomly selected interpolated and summed noise pattern images, σ_f is a desired standard deviation desired for the simulated patient image, σ_o is a standard deviation of said actual patient image and α is a tube current reduction factor relative to a tube current at which said actual patient image was taken.

[c36] 36.The imaging system of claim 35, wherein said noise pattern images are scaled by the inverse square root of the number of said noise pattern images selected.

[c37] 37.A storage medium, comprising:
a machine readable computer program code for generating a simulated patient image; and
instructions for causing a computer to implement a method, the method further comprising:
obtaining image data from an actual patient image;
generating simulated noise data; and
combining said image data with said simulated noise data to create the simulated patient image.

[c38] 38.The storage medium of claim 37, further comprising:
combining scan data from said actual patient image with said generated

simulated noise data to create pre-image data; and

reconstructing said pre-image data to create simulated image data.

[c39] 39.The storage medium of claim 38, wherein said simulated noise data is generated through a random number generator in accordance with a Poisson distribution.

[c40] 40.The storage medium of claim 39, wherein individual scan data samples from said scan data are each combined with a random noise value generated from said Poisson distribution random number generator, said random noise value first being multiplied by a weighting factor to produce a weighted random noise value.

[c41] 41.The storage medium of claim 40, wherein said weighting factor is determined in accordance with the equation:

$$a = \beta\sqrt{D\left(\frac{1}{\alpha}-1\right)}$$

wherein a is said weighting factor, β is a scale factor whose value depends on a data acquisition system (DAS) gain and the image processing characteristics, α is a tube current reduction factor relative to a tube current at which said actual patient image was taken, and D is a DAS signal level for a corresponding individual scan data sample.

[c42] 42.The storage medium of claim 41, wherein, in addition to said weighting factor, each of said random noise values are further multiplied by an electronic noise scale factor prior to being combined with individual scan data samples, said electronic noise scale factor being determined in accordance with the equation:

$$\sigma_a = aN_nP$$

wherein N_n is said electronic noise scale factor due to non-quantum noise, a is said weighting factor, P is said random noise value generated from said Poisson distribution random number generator, and σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image.

[c43] 43.The storage medium of claim 37, further comprising:

creating a set of individual noise pattern images for each a plurality of phantom

objects;

selecting at least one of said individual noise pattern images to be combined with said actual patient image; and

combining said at least one selected individual noise pattern image with said actual patient image, thereby creating the simulated patient image.

[c44] 44.The storage medium of claim 43, wherein said selecting at least one of said individual noise pattern images is based upon a patient shape and an imaging technique.

[c45] 45.The storage medium of claim 43, wherein said at least one of said individual noise pattern images is randomly selected.

[c46] 46.The storage medium of claim 45, wherein if more than one of said individual noise pattern images is selected, then said noise pattern images are added together to produce a resultant noise pattern.

[c47] 47.The storage medium of claim 46, wherein said combined noise pattern is scaled by a scaling factor, ,sin accordance with the equation:

$$s = \frac{\sigma_a}{\sigma_p} \quad \text{; with}$$

$$\sigma_a = \sqrt{\sigma_f^2 - \sigma_0^2} = \sigma_0 \sqrt{\left(\frac{1}{\alpha} - 1\right)}$$

wherein, σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image, σ_p is a standard deviation of randomly selected interpolated and summed noise pattern images, σ_f is a desired standard deviation desired for the simulated patient image, σ_o is a standard deviation of said actual patient image and α is a tube current reduction factor relative to a tube current at which said actual patient image was taken.

[c48] 48.The storage medium of claim 47, wherein said noise pattern images are scaled by the inverse square root of the number of said noise pattern images selected.

[c49] 49.A computer data signal, comprising:

code configured to cause a processor to implement a method for generating a

simulated patient image, the method further comprising:
obtaining image data from an actual patient image;
generating simulated noise data; and
combining said image data with said simulated noise data to create the simulated patient image.

[c50] 50.The computer data signal of claim 37, further comprising:
combining scan data from said actual patient image with said generated simulated noise data to create pre-image data; and
reconstructing said pre-image data to create simulated image data.

[c51] 51.The computer data signal of claim 50, wherein said simulated noise data is generated through a random number generator in accordance with a Poisson distribution.

[c52] 52.The computer data signal of claim 51, wherein individual scan data samples from said scan data are each combined with a random noise value generated from said Poisson distribution random number generator, said random noise value first being multiplied by a weighting factor to produce a weighted random noise value.

[c53] 53.The computer data signal of claim 52, wherein said weighting factor is determined in accordance with the equation:

$$a = \beta\sqrt{D\left(\frac{1}{\alpha}-1\right)}$$

wherein a is said weighting factor, β is a scale factor whose value depends on a data acquisition system (DAS) gain and the image processing characteristics, α is a tube current reduction factor relative to a tube current at which said actual patient image was taken, and D is a DAS signal level for a corresponding individual scan data sample.

[c54] 54.The computer data signal of claim 53, wherein, in addition to said weighting factor, each of said random noise values are further multiplied by an electronic noise scale factor prior to being combined with individual scan data samples, said electronic noise scale factor being determined in accordance with the equation:

$\sigma_a = aN_n P$

wherein N_n is said electronic noise scale factor due to non-quantum noise, as said weighting factor, P is said random noise value generated from said Poisson distribution random number generator, and σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image.

[c55] 55.The computer data signal of claim 49, further comprising:
creating a set of individual noise pattern images for each a plurality of phantom objects;
selecting at least one of said individual noise pattern images to be combined with said actual patient image; and
combining said at least one selected individual noise pattern image with said actual patient image, thereby creating the simulated patient image.

[c56] 56.The computer data signal of claim 55, wherein said selecting at least one of said individual noise pattern images is based upon a patient shape and an imaging technique.

[c57] 57.The computer data signal of claim 55, wherein said at least one of said individual noise pattern images is randomly selected.

[c58] 58.The computer data signal of claim 57, wherein if more than one of said individual noise pattern images is selected, then said noise pattern images are added together to produce a resultant noise pattern.

[c59]

59.The computer data signal of claim 58, wherein said combined noise pattern is scaled by a scaling factor, s, in accordance with the equation:

$$s = \frac{\sigma_a}{\sigma_p} \quad \text{; with}$$

$$\sigma_a = \sqrt{\sigma_f^2 - \sigma_o^2} = \sigma_o \sqrt{\left(\frac{1}{\alpha} - 1\right)}$$

wherein, σ_a is a standard deviation of said generated simulated noise data to be combined with said actual patient image, σ_p is a standard deviation of randomly selected interpolated and summed noise pattern images, σ_f is a desired standard deviation desired for the simulated patient image, σ_o is a standard deviation of said actual patient image and α is a tube current

reduction factor relative to a tube current at which said actual patient image was taken.

[c60] 60.The storage medium of claim 59, wherein said noise pattern images are scaled by the inverse square root of the number of said noise pattern images selected.